## REMARKS

Claims 1-21 are currently pending in the application. By this amendment, claims 1-4 and 10 are amended. The above amendments are formal in nature and do not add new matter to the application. Reconsideration of the rejected claims in view of the above amendments and the following remarks is respectfully requested.

### *Allowable Claims*

Applicant appreciates the indication that claims 19-21 contain allowable subject matter and would be allowed if presented in independent form. However, at this time, Applicant is not presenting these claims in independent form because it is believed that claim 3 is allowable. Additionally, Applicants submit that all pending claims are in condition for allowance for the following reasons.

### *Drawing Objection*

The drawings were objected to because, it is alleged, that the features of claims 6, 7, 17 and 18 are not shown.

Applicant submits that no additional illustration is required. Under current USPTO rules, features which are conventional can be shown with nothing more than a box.

Applicant submits that claims 6 and 7 describe a thermocouple with certain recited features which are conventional and therefore need not be shown in detail (see Rule 1.82(a) which explains that conventional features can be shown with a labeled

rectangular box). Applicant notes that Fig. 1A clearly illustrates the thermocouple as reference number 15 (see also page 17, line 7 of the instant specification). Evidence of the fact that such thermocouples are convention can even be found in US Patent No. 6,048,510 (which was applied by the Examiner in the instant Office Action) which discusses such thermocouples on col. 17, lines 13-27. Applicant notes that this document was specifically incorporated by reference in the instant application (see page 13, line 14 of the instant specification).

With regard to claims 17 and 18, Applicant submits no additional illustration is required because the recited features are shown in Figs. 2A-2D and described on page 18, lines 4-18 of the instant specification. The specification explains that nozzles of the type shown in e.g., Fig. 2A can deliver fuel and air as well as fluid and air and that these nozzles can be located at the different locations shown in e.g., Fig. 1A.

Accordingly, Applicant respectfully requests that the instant drawing objection be withdrawn and that the drawings are accepted.

***Claim Objection***

Claim 10 was objected to because it is alleged to be inconsistent with claim 1 from which it depends.

By this Amendment, Applicant has amended claim consistent with the Examiner's comments. As a result, claim 10, as amended herein, is believed to be consistent with claim 1.

Accordingly, Applicant respectfully requests that the instant claim objection be withdrawn.

***The Invention***

As is explained at length in the Description of Prior Art section, an objective of the instant invention is to reduce nitrogen oxide, $NO_x$, emissions from existing gas turbines that currently have little or no $NO_x$ controls, a goal that would allow such turbines to operate during peaking applications, such as occur during hot summer heat waves, (see page 1, line 17 through page 2, line 18 of the instant specification). The literal explosion in natural gas prices recently has made such a capability even more urgent in that old gas turbines could then be pressed into service with the present $NO_x$ controls. On the other hand, the modern combined steam-gas turbine power plants that must operate continuously cannot do so economically with natural gas fired gas turbines during periods of low power demand.

Therefore, the focus of this invention is on $NO_x$ control. The Prior Art section of the instant specification discusses the previous and current various $NO_x$ reduction processes. Page 3 discusses water injection for $NO_x$ control; page 4 line 1 deals with steam injection, which only is realistic for combined steam-gas turbine power plants that generate the needed steam, and page 4, line 20 deals with staged combustion $NO_x$ control. Page 5, line 15 deals with Selective Catalytic Reduction, (SCR) a process so costly that it only is economic in baseline combined cycle power plants, which as noted cannot now operate economically with current natural gas prices.

A key aspect of the present invention is that it reduces $NO_x$ without any changes to the design of the existing gas turbines combustion chambers. The prior art applied in the instant Office Action, on the other hand, is simply not relevant.

As will be explained in detail in addressing the rejections, WILKES relates to a variation of a staged combustor that is usually used to reduce $NO_x$ in coal fired combustors. While this is an application that is noted by the inventor for gas turbines, such an arrangement is totally unrealistic for gas turbines, as all such efforts over many decades have failed. Also, in the present invention, the primary combustion zone is preferably operated fuel lean to eliminate unburned hydrocarbon and minimize carbon monoxide.

Zauderer relates to coal fired boilers and contains no hint that it could have application to gas turbines, which deal with totally different fuels and different operating conditions from coal fired boilers. This document is not concerned with reductions in $NO_x$ implemented without modifications (e.g. page 14, line 11) to the combustion chamber of a gas turbine. Applicant notes, for example, that the differences in $NO_x$ reduction in a gas turbine versus a coal combustor are described at length in the instant specification. For example, one key difference is that in coal combustors, fuel bound nitrogen is the primary $NO_x$ generator, and staged combustion with a primary fuel rich zone is used for the much of the $NO_x$ reduction.

On the other hand, the present invention has application for fuel lean primary combustion even with oil that has some fuel bound nitrogen because gas turbines have much shorter gas residence times than coal. Therefore, good combustion is critical in

order to reduce unburned carbon and minimize carbon monoxide. The present invention therefore can be used with lean combustion with natural gas as well as with oil, and in the latter fuel, the use of very fine atomizing nozzles are disclosed to achieve good combustion in primary zone 61, Fig. 1 [Page 11, 1st paragraph]. Unlike coal combustors, where it is not used, water droplet cooling can be used in zone 7, Fig. 1A, as a means for limiting thermal $NO_x$, which is generally not a problem in coal combustion (see p 11, 1st paragraph), and as a means for conditioning the gas for the SNCR process. A key step can occur in zone 8, Fig. 1A, where SNCR is used to sharply lower $NO_x$ (see page 11, 1st para.). Here there is a major, and very critical, difference from the coal combustion SNCR that is disclosed in Zauderer. While ammonia slip, from urea or ammonia injection outside the operating gas temperature range zone also must be limited in a coal-fired boiler, some ammonia slip of say 5 ppm is tolerated in coal fired boilers, but could be catastrophic in long term use for gas turbines. The reason is that ammonia reacts with copper, such as are used in gas turbine bearings. Their corrosion could severely damage the turbine (See page 9, line 22, and top of page 10). This is the reason for the emphasis on gas temperature measurements upstream of the SNCR zone 8 to assure that injection occurs in the temperature range where ammonia slip is eliminated.

Furthermore, to be absolutely certain that there is no ammonia slip, a non-limiting embodiment of the invention disclose mixing the $NO_x$ reducing agent, ammonia or urea, with a solvent such as methanol or alcohol and then re-burning in combustor zone 8 (see Fig. 1A) to fuel rich conditions at which not only is the $NO_x$ reduced but all

ammonia is destroyed. The methodology for implementing re-burning with injector 9, in Fig. 1, is described on page 30, beginning with line 5. Also, the tests in the small gas turbine (which are discussed page 32-51 of the instant specification) disclose the work on SNCR injection, including preparing and injecting into the 120 hp small gas turbine. SNCR reagents mixe with liquid fuels. As disclosed on page 50 (see paragraph beginning on line 12), the tests with ammonia or urea in the small gas turbine did not reduce $NO_x$. In fact the reverse occurred, NOx increased sharply. This was attributed to the small size of the 120 hp-combustion gas turbine. This proves that this process SNCR-Reburning is not obvious, and tests in larger gas turbines are indicated to resolve this because the process clearly works in coal fired boilers.

In conclusion, the present invention uses the teachings of Zauderer as a starting point. However, there are very significant differences when trying to achieve large $NO_x$ reductions in gas turbines, teachings that were aided by the tests on the 120 hp gas turbine described in the specification. Finally, as noted above, the explosion in the price of natural gas this past year, 2005, has made it uneconomical to operate gas turbine power plants as baseline round-the-clock operation. However, during hours of peak demand on hot days, the revenue paid for power to the Electric Grids far exceeds the cost of operating even a gas-fired power plant. Therefore, the present invention in which even oil fired operation can be used with sharply reduced $NO_x$, renders this invention particularly timely for use with old, high $NO_x$ producing oil fired gas turbines.

***35 U.S.C. § 103(a) Rejection***

*Over Wilkes with Zauderer*

Claims 1, 3, 5-11 and 13-16 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,958,488 to WILKES et al. in view of U.S. Patent No. 6,048,510 to ZAUDERER.

The Examiner makes various assertions of obviousness on the basis of the combination of the above-noted documents. Applicant respectfully disagrees with the rejection.

Independent claims 1 and 3 recite, *inter alia,*

> varying hydraulic or air atomizing pressure in at least one injector in order to permit distribution and vaporization of different sized droplets at different locations within said gas combustion temperature zone, taking place during said injecting step; and
>
> adjusting a position of an injector droplet outlet of said at least one injector within said combustion chamber based on an outer edge of said gas combustion temperature zone identified in said identifying step, said adjusting step positioning said injector droplet outlet adjacent to said outer edge of said gas combustion temperature zone identified in said identifying step.

Furthermore, Independent claim 1 recites, *inter alia,*

> identifying a gas combustion temperature zone within said combustion chamber that is downstream of a zone of initial gasification of said liquid fuel and initial combustion of said liquid or gaseous carbonaceous fuel and where in an absence of any steps to cool a downstream gas temperature zone, approximately above 2500° F., thermal $NO_x$ production is provided;
>
> injecting water droplets of varying size between 10 $\mu$m to 1000 $\mu$m by means of one or more nozzles that form a flat, planar, fan shaped, spray pattern which is oriented perpendicular to said effluent gas stream and is of cross-sectional area to intercept all of the effluent gas stream in said gas combustion temperature zone, and whose mean and maximum size of said droplets depend on the dimensions of said gas combustion temperature zone in said chamber.

Additionally, Independent claim 3 recites, *inter alia,*

identifying a gas combustion temperature zone within said combustion chamber whose gas temperature is between 1700° F. and 2200° F. and that is immediately downstream of the gas combustion temperature zone of initial gasification of said liquid fuel and initial combustion of said liquid or gaseous carbonaceous fuel;

injecting water droplets, containing an aqueous solution of a $NO_x$ reducing agent, including one of ammonia and urea, of varying size between 10 $\mu$m to 1000 $\mu$m by means of one or more nozzles that form a flat, planar, fan shaped spray pattern which is oriented perpendicular to said effluent gas stream and is of sufficient cross-sectional area to intercept all of the effluent gas stream in a downstream combustion temperature zone, and whose mean and maximum size of said droplets depend on the dimensions of said downstream gas temperature zone in said combustion chamber.

Applicant respectfully submits that no proper combination of the applied documents discloses or suggests at least these features.

The Examiner alleges that WILKES teaches all of the above-noted recited features except for "adjusting the pressure or the position of the nozzles" and except for the recited "$NO_x$ reducing agent". However, the Examiner asserts that such features are taught by ZAUDERER at col. 31, lines 48+ and that it would have been obvious to combine the teachings of these documents. Applicant respectfully disagrees.

As an initial matter, the Examiner is not correct that WILKES teaches all of the claim features with the exception of "adjusting the pressure or the position of the nozzles" and the recited "$NO_x$ reducing agent". WILKES is entirely silent with regard to, for example, varying hydraulic or air atomizing pressure in an injector in order to permit distribution and vaporization of different sized droplets at different locations within said gas combustion temperature zone, taking place during said injecting step.

Nor has the Examiner properly characterized the claim language. Claims 1 and 3 do not merely recite "adjusting the pressure or the position of the nozzles" and an

"$NO_x$ reducing agent", as alleged by the Examiner. Instead, claims 1 and 3 recite adjusting a position of an injector droplet outlet of said at least one injector within said combustion chamber based on an outer edge of said gas combustion temperature zone identified in said identifying step, said adjusting step positioning said injector droplet outlet adjacent to said outer edge of said gas combustion temperature zone identified in said identifying step. These features are not disclosed or suggested by either WILKES or ZAUDERER, and the Examiner has not demonstrated otherwise.

Applicant acknowledges that WILKES discloses a combustion system which utilizes the downstream injection of a coolant via coolant supply pipes 80 (see col. 3, lines 16-25) and that the disclosed system aims to lower the level of oxides of nitrogen (see col. 4, lines 31-35). However, what the Examiner characterizes as nozzles are in fact merely conduits 80 whose ends are filed to the flange 70 (see Fig. 3 ). Clearly, such conduits are not configured to use on a process which adjusts a position of an injector droplet outlet of said at least one injector within said combustion chamber based on an outer edge of said gas combustion temperature zone identified in said identifying step, said adjusting step positioning said injector droplet outlet adjacent to said outer edge of said gas combustion temperature zone identified in said identifying step.

WILKES also does not disclose or suggest urea or ammonia injection as a means for reducing $NO_x$ in gas turbine combustion and the Examiner has not shown otherwise.

Moreover, ZAUDERER does not cure the deficiencies of WILKES. ZAUDERER relates to reducing $NO_x$ in the combustion chambers of utility or firing boilers (see col. 1,

lines 10-14, col. 10, lines 39-41, and col. 11, lines 66-67). While Applicant does not dispute that ZAUDERER discloses a combustion system which utilizes the downstream injection of a $NO_x$ reducing agent using nozzles (see col. 10, line 54 to col. 11, line 10) and that the disclosed system aims to lower the level of nitrogen oxide, the Examiner has failed to explain why one having ordinary skill in the art would utilize the nozzles of a coal firing boiler in the gas turbine engine of WILKES. Nor has the Examiner explained where in ZAUDERER there contains disclosure with regard to, among other things, adjusting a position of an injector droplet outlet of said at least one injector within said combustion chamber based on an outer edge of said gas combustion temperature zone identified in said identifying step, said adjusting step positioning said injector droplet outlet adjacent to said outer edge of said gas combustion temperature zone identified in said identifying step.

Even more revealing, ZAUDERER, like WILKES, does not disclose or suggest, for example, using *water* in the droplet injection system as a means for directly reducing $NO_x$. Nor does it disclose or suggest using water as a means for conditioning the combustion gases to the proper SNCR injection zone gas temperature *upstream* of the SNCR injection zone where a separate droplet injection system is utilized. In fact, it would not be apparent to one of ordinary skill in the art to modify ZAUDERER because of the well known corrosive effect of ammonia on copper components in gas turbines. This is the reason for Applicant's focus on ensuring that the SNCR urea-ammonia injection takes place at the proper gas temperature zone in order to prevent ammonia gas from slipping downstream of the SNCR injection zone and attacking copper gas

turbine components. In addition, the instant invention provides an alternate SNCR process in which a fuel rich SNCR injection zone is created by mixing liquid fuel with the urea/ammonia solution which will definitely decompose ammonia and any excess ammonia that does not react with $NO_x$ molecules.

Applicant submits that it would not have been obvious to combine these documents, at leas for the following reasons:

(1) Neither WILKES nor ZAUDERER teach adjusting a position of an injector droplet outlet of said at least one injector within said combustion chamber based on an outer edge of said gas combustion temperature zone identified in said identifying step, said adjusting step positioning said injector droplet outlet adjacent to said outer edge of said gas combustion temperature zone identified in said identifying step. Indeed, the Examiner has failed to identify these features in either of the applied documents;

(2) Neither WILKES nor ZAUDERER teach varying hydraulic or air atomizing pressure in at least one injector in order to permit distribution and vaporization of different sized droplets at different locations within said gas combustion temperature zone, taking place during said injecting step. As noted above, the pipes 80 in WILKES are not nozzles. Moreover, ZAUDERER is only concerned with reducing $NO_x$ in a coal fired burner and does not disclose or suggest at least these features;

(3) Neither WILKES nor ZAUDERER teach injecting water droplets of varying size between 10 $\mu$m to 1000 $\mu$m by means of one or more nozzles that form a flat, planar, fan shaped, spray pattern which is oriented perpendicular to said effluent gas stream and is of cross-sectional area to intercept all of the effluent gas stream in said

gas combustion temperature zone, and whose mean and maximum size of said droplets depend on the dimensions of said gas combustion temperature zone in said chamber, or injecting water droplets, containing an aqueous solution of a $NO_x$ reducing agent, including one of ammonia and urea, of varying size between 10 $\mu$m to 1000 $\mu$m by means of one or more nozzles that form a flat, planar, fan shaped spray pattern which is oriented perpendicular to said effluent gas stream and is of sufficient cross-sectional area to intercept all of the effluent gas stream in a downstream combustion temperature zone, and whose mean and maximum size of said droplets depend on the dimensions of said downstream gas temperature zone in said combustion chamber.

(4) Applicant emphasizes that the use of urea or ammonia to reduce $NO_x$ in carbonaceous boilers, as disclosed in ZAUDERER, would not suggest any application to gas turbines due to the corrosive of the chemicals on critical copper components, such as bearings in gas turbines. Therefore, for gas turbines, Applicant specifically teaches the placement of the urea or ammonia injectors in the proper gas temperature zone, a feature which would be particularly important to the boiler of ZAUDERER.

(5) Also, as stated above, to prevent even minute concentrations of ammonia in the range of several parts per million from slipping downstream from the urea or ammonia injections zones in the gas turbine combustion chamber, Applicant teaches the use of mixing the urea or ammonia with liquid fuels, such as methanol, to convert the injection zone to fuel rich conditions which will decompose the ammonia and additionally further reduce $NO_x$. The use of costly liquid fuel may be economically justified for peaking gas turbines, but would not be so for solid fuel fired boilers.

Accordingly, Applicant submits that it would not have been obvious to combine these documents, and even if these documents were properly combinable, they would still fail to disclose or suggest the combination of features recited in at least claims 1 and 3. Furthermore, dependent claims 5-11 and 13-16 recite additional features which are not disclosed, or even suggested, by any proper combination of the above-noted documents and the Examiner has not shown otherwise.

Accordingly, Applicant respectfully submits that the rejections under 35 U.S.C. § 103(a) should be withdrawn.

*Over Lysholm with Zauderer and Paczkowski*

Claims 1-18 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 1,988,456 to LYSHOLM in view of ZAUDERER and further optionally in view of U.S. Patent No. 4,448,577 to PACZKOWSKI.

The Examiner makes various assertions of obviousness on the basis of the combination of the above-noted documents. Applicant respectfully disagrees with the rejection.

Independent claims 1-4 as recited in representative claim 1, *inter alia,*

> varying hydraulic or air atomizing pressure in at least one injector in order to permit distribution and vaporization of different sized droplets at different locations within said gas combustion temperature zone, taking place during said injecting step; and
>
> adjusting a position of an injector droplet outlet of said at least one injector within said combustion chamber based on an outer edge of said gas combustion temperature zone identified in said identifying step, said adjusting step positioning said injector droplet outlet adjacent to said outer edge of said gas combustion temperature zone identified in said identifying step.

Applicant respectfully submits that no proper combination of the applied documents discloses or suggests at least these features.

The Examiner alleges that LYSHOLM teaches all of the above-noted recited features except for "the temperature of the combustion zones", except for the "adjusting the pressure or the position of the nozzles" and except for the recited "$NO_x$ reducing agent". However, the Examiner asserts that the recited temperatures are conventionally known and that the adjusting and the recited $NO_x$ reducing agent are taught by ZAUDERER at col. 31, lines 48+, and that it would have been obvious to combine the teachings of these documents. Finally, the Examiner cites PACZKOWSKI in support of the assertion that the use of upstream facing nozzles is well known. Applicant respectfully disagrees.

The Examiner is not correct that LYSHOLM teaches all of the claim features with the exception of the recited temperature, adjusting the pressure or the position of the nozzles, and the recited $NO_x$ reducing agent. LYSHOLM is entirely silent with regard to, for example, varying hydraulic or air atomizing pressure in an injector in order to permit distribution and vaporization of different sized droplets at different locations within said gas combustion temperature zone, taking place during said injecting step.

Nor has the Examiner properly characterized the claim language. Claims 1-4 do not merely recite "adjusting the pressure or the position of the nozzles" and an "$NO_x$ reducing agent", as alleged by the Examiner. Instead, claims 1-4 substantially recite adjusting a position of an injector droplet outlet of said at least one injector within said combustion chamber based on an outer edge of said gas combustion temperature zone

identified in said identifying step, said adjusting step positioning said injector droplet outlet adjacent to said outer edge of said gas combustion temperature zone identified in said identifying step. These features are not disclosed or suggested by any of these documents, and the Examiner has not demonstrated otherwise.

Applicant acknowledges that LYSHOLM discloses a combustion system and that the disclosed system utilizes the downstream injection of a coolant via nozzles 38-40 (see Fig. 2). However, the Examiner has failed to note that the disclosed system in LYSHOLM uses the nozzles merely to increase "the specific heat of the gaseous motive fluid" (see page 1, col. 1, lines 17-21) and "to reduce or prevent the formation of soot" (see page 2, col. 2, lines 13-15). There is no disclosure or concern in LYSHOLM with regard to reducing $NO_x$. Nor is there any apparent disclosure in LYSHOLM with regard to adjusting a position of an injector droplet outlet of said at least one injector within said combustion chamber based on an outer edge of said gas combustion temperature zone identified in said identifying step, said adjusting step positioning said injector droplet outlet adjacent to said outer edge of said gas combustion temperature zone identified in said identifying step.

Furthermore, ZAUDERER does not cure the deficiencies of LYSHOLM. As explained above in connection with ZAUDERER and WILKES, ZAUDERER relates to reducing $NO_x$ in the combustion chambers of utility or firing boilers (see col. 1, lines 10-14, col. 10, lines 39-41, and col. 11, lines 66-67). While Applicant does not dispute that ZAUDERER discloses a combustion system which utilizes the downstream injection of a $NO_x$ reducing agent using nozzles (see col. 10, line 54 to col. 11, line 10) and that the

disclosed system aims to lower the level of nitrogen oxide, the Examiner has failed to explain why one having ordinary skill in the art would utilize the nozzles of a coal firing boiler in the gas turbine engine of LYSHOLM.

Nor has the Examiner explained where in ZAUDERER there contains disclosure with regard to, among other things, adjusting a position of an injector droplet outlet of said at least one injector within said combustion chamber based on an outer edge of said gas combustion temperature zone identified in said identifying step, said adjusting step positioning said injector droplet outlet adjacent to said outer edge of said gas combustion temperature zone identified in said identifying step.

Applicant also submits that PACZKOWSKI fails to cure the deficiencies of either LYSHOLM and ZAUDERER. While Applicant does not dispute that PACZKOWSKI discloses a water nozzle 16 which injects water in an upstream direction of a combustion flow, the Examiner has failed to appreciate that PACZKOWSKI relates to a device for producing inter gasses (see col. 1, lines 4-7). There is no disclosure or concern in LYSHOLM with regard to reducing $NO_x$. Nor is there any disclosure in PACZKOWSKI with regard to adjusting a position of an injector droplet outlet of said at least one injector within said combustion chamber based on an outer edge of said gas combustion temperature zone identified in said identifying step, said adjusting step positioning said injector droplet outlet adjacent to said outer edge of said gas combustion temperature zone identified in said identifying step.

Accordingly, Applicant submits that it would not have been obvious to combine these documents, and even if these documents were properly combinable, they would

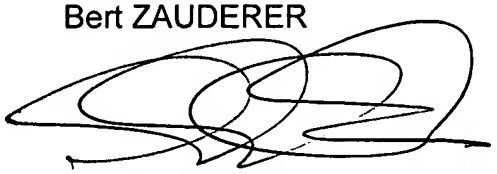
still fail to disclose or suggest the combination of features recited in at least claims 1-4. Furthermore, dependent claims 5-18 recite additional features which are not disclosed, or even suggested, by any proper combination of the above-noted documents and the Examiner has not shown otherwise.

Accordingly, Applicant respectfully submits that the rejections under 35 U.S.C. § 103(a) should be withdrawn.

## CONCLUSION

In view of the foregoing amendments and remarks, Applicant submits that all of the claims are patentably distinct from the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue. The Examiner is invited to contact the undersigned at the telephone number listed below, if needed. Applicant hereby makes a written conditional petition for extension of time, if required. Please charge any deficiencies in fees and credit any overpayment of fees to Deposit Account No. 19-0089.

Respectfully submitted,
Bert ZAUDERER



November 7, 2005
Greenblum & Bernstein, P.L.C.
1950 Roland Clarke Place
Reston, Virginia 20191
Telephone: 703-716-1191
Facsimile: 703-716-1180

Andrew M. Calderon
Registration No. 38,093